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ABSTRACT

VALIDATION OF THE EFFECTIVENESS

OF THE PROJECT DEFINITION PHASE

OF U.S. AIR FORCE MILITARY CONSTRUCTION PROJECTS

by

ROBERT MATTHEW CRAFTON

CAPTAIN, UNITED STATES AIR FORCE

MASTER OF SCIENCE IN ENGINEERING

THE UNIVERSITY OF TEXAS AT AUSTIN

1995

(88 Pages)

In 1990, the U.S. Air Force initiated a phase in the Military Construction Process known as Project Definition. The intention of the Air Force in initiating this phase was twofold: first, to improve customer satisfaction with the facility provided, and second, to reduce design changes throughout the construction project. The purpose of this research is to investigate the effect the Project Definition phase has in producing a successful project Design Phase. For data collection, project participants on twenty-five Air Force Center for Environmental Excellence projects were surveyed. From the data collected, the Project Definition efforts were rated and compared to the subsequent success of the design efforts. Trends among the twenty-five projects were analyzed and conclusions and recommendations are given. Key bibliographic sources include *The United States Air Force Project Manager's Guide For Project Definition* and the Construction Industry Institute's *Pre-Project Planning Handbook.*

VALIDATION OF THE EFFECTIVENESS
OF THE PROJECT DEFINITION PHASE
OF U.S. AIR FORCE MILITARY CONSTRUCTION PROJECTS

by

ROBERT MATTHEW CRAFTON, B.S.C.E.

THESIS

Presented to the Faculty of the Graduate School

of The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE IN ENGINEERING

THE UNIVERSITY OF TEXAS AT AUSTIN

December 1995

VALIDATION OF THE EFFECTIVENESS

OF THE PROJECT DEFINITION PHASE

OF U.S. AIR FORCE MILITARY CONSTRUCTION PROJECTS

APPROVED BY

SUPERVISING COMMITTEE:

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Richard L. Tucker

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ABSTRACT

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SUPERVISOR: RICHARD L. TUCKER

In 1990, the U.S. Air Force initiated a phase in the Military Construction Process known as Project Definition. The intention of the Air Force in initiating this phase was twofold: first, to improve customer satisfaction with the facility provided, and second, to reduce design changes throughout the construction project. The purpose of this research is to investigate the effect the Project Definition phase has in producing a successful project Design Phase. For data collection, project participants on twenty-five Air Force Center for Environmental Excellence projects were surveyed. From the data collected, the Project Definition efforts were rated and compared to the subsequent success of the design efforts. Trends among the twenty-five projects were analyzed and conclusions and recommendations are given.

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1.0 Introduction

In 1990, the U.S. Air Force initiated a phase in the Military Construction (MILCON) Process known as Project Definition. The intention of the Air Force in initiating this phase was twofold: first, to improve customer satisfaction with the facility provided, and second, to reduce design changes throughout the construction project. Specifically, Project Definition is that phase in the military construction process in which an architect-engineering firm or an in-house designer collects user requirements and then conducts on-site, preliminary analysis and design.

1.1 Purpose

The purpose of this research is to investigate the effectiveness of the Project Definition phase in achieving its intended purposes. The hypothesis is that if the Project Management Team for an Air Force construction project fully and effectively follows the Project Definition process, as outlined in *The U.S. Air Force Project Manager's Guide to Project Definition*, then a more successful design effort will result.

1.2 Scope

This research will focus only on the Project Definition phase of the MILCON process. To evaluate the effectiveness of Project Definition, twenty-five Air Force Center for Environmental Excellence/Construction Management Office (AFCEE/CMO) projects were studied. The projects were each chosen because Project Definition and design had been completed. The projects are of varying types and sizes, ranging from an aircraft parking apron to a dormitory renovation and ranging in cost from $1.0 Million to $19.5 Million. While this research was conducted

primarily for AFCEE, its results should benefit other Major Commands and construction project managers throughout the Air Force.

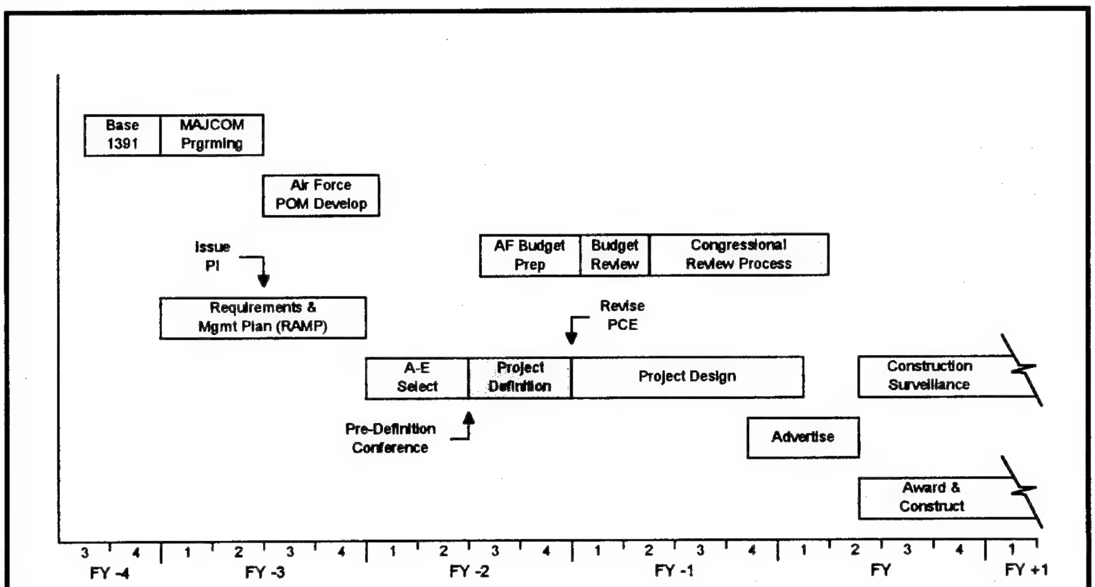
1.3 Thesis Organization

Chapter 2 of this thesis consists of a background explanation of the MILCON process, Project Definition, and AFCEE organization. Also, the Construction Industry Institute's research into pre-project planning as well as metrics and benchmarking are briefly discussed in Chapter 2. Chapter 3 describes the methodology used for this research, including an explanation of the matrices used to evaluate the projects, the development of the research questionnaires, and a listing of the projects studied. Chapter 4 presents the results of the research and an analysis of the results. Chapter 5 presents conclusions, and Chapter 6 discusses recommendations.

2.0 Background

2.1 The U.S. Air Force Military Construction Process

The process by which an Air Force construction project is conceived, funded, designed and completed is complex, lengthy, and heavily regulated. It involves numerous people from several levels of the U.S. government. Figure 2.1 shows a rough timeline of the Military Construction (MILCON) process from the initial request for the project to the start of the construction phase (USAF CE 1991). The following is a brief explanation of the Air Force MILCON process; it is not intended to be exhaustive. For a more in-depth discussion of the process, *The United States Air Force Project Manager's Guide for Design and Construction* (1991) is recommended, from which this explanation was taken.



NOTE: MAJCOM (Major Command) PI (Planning Instruction)
POM (Program Objectives Memorandum) A-E (Architect-Engineering Firm)
PCE (Parametric Cost Estimate)

Figure 2.1
USAF Military Construction Process

Typically, to initiate the MILCON process, an organization on an Air Force base requests a new facility, an addition, or renovation of an existing facility through the base civil engineering (BCE) squadron. If the request is valid and fits within the base's long-range plans, the BCE is responsible for completing a Department of Defense Form 1391, which outlines the project scope, cost, and features. This form is sent with other requests for construction from the base to a Major Command (MAJCOM), which oversees the operations of several different bases. After the construction requirement is approved at this level, each MAJCOM then sends all of the requests for construction to Headquarters U.S. Air Force/Civil Engineer (HQ USAF/CE). HQ USAF/CE compiles, validates, and approves or disapproves all requests sent from the MAJCOMs. If the project is approved, HQ USAF/CE issues a Planning Instruction (PI) to the MAJCOM. The PI is the formal notification that advanced planning on the project may begin at the command's discretion.

The PI authorizes the MAJCOM to initiate design activities, and generally, at this time, the Requirements and Management Plan (RAMP) is completed. The RAMP consists of two parts: the requirements part consisting of a brief project description, general and special requirements, and a parametric cost estimate; and a project management plan including a listing of the project management team and project strategic decisions.

Also at this time, a Design Agent is appointed by the government. Due to U.S. congressional regulations, the design and construction phases of most Air Force projects are managed by the U.S. Army Corps of Engineers or the U.S. Navy Facilities Engineering Command (NAVFAC). Thus, the Design Agent is ultimately responsible for the design of the project and all government dealings with private firms.

The next phase in the process is the selection of the Architect-Engineering firm (A-E) who will design the project. Usually, interested A-Es respond to announcements made in the *Commerce Business Daily*, which carries listings of

project descriptions, qualifications required, and critical need dates. The A-E is selected based on recent specific experience and expertise related to the project. For current Air Force projects, the A-E usually must demonstrate past experience with conducting on-site data gathering, analysis, and design charrettes. Charrettes will be defined and explained in Section 2.2. Occasionally, the Design Agent may decide to have the design conducted by in-house government personnel rather than a private A-E firm.

Once the A-E is selected, project participants meet at the Pre-Definition Conference. This conference is attended by the requesting base organization (facility end user or future occupant), the BCE, the A-E, the Air Force Project Manager, and the Design Agent. At the conference, general design requirements are established, base design and environmental standards are reviewed, all project team member responsibilities are defined, and a cost for services is requested from the A-E.

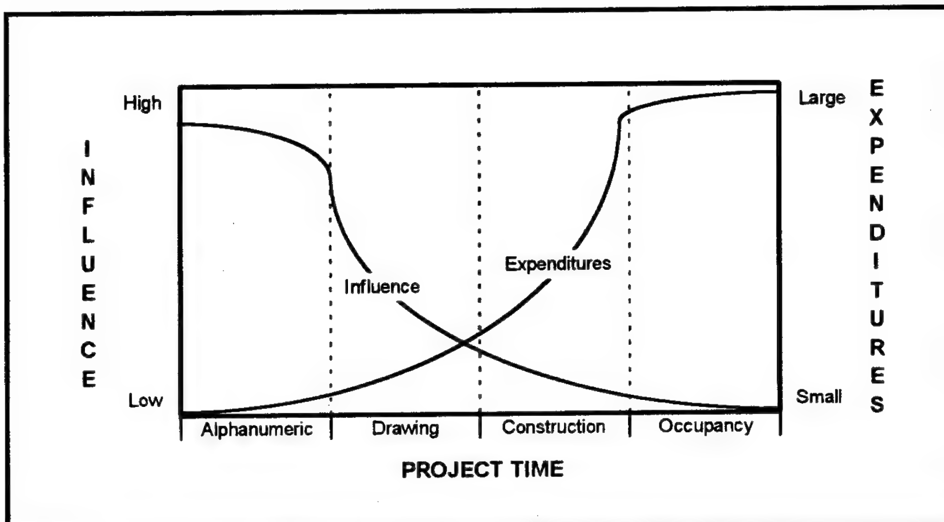
The pre-definition conference begins the Project Definition phase, which will be discussed in detail in Section 2.2. At the end of Project Definition, a preliminary design and a parametric cost estimate (PCE) are produced by the A-E. Rather than a detailed cost estimate based on quantities of various materials, the parametric cost estimate is an estimate based on facility type, square footage, and the estimator's experience. The PCE developed during Project Definition is used to update the DD Form 1391, which is then sent to the MAJCOM and subsequently to HQ USAF for budget preparation. The Office of the Secretary of Defense then reviews each service's construction requirements and prepares the final Department of Defense budget. The defense budget is then included in the President's budget and sent to Congress. After Congress reviews the defense budget, it is approved through an authorization bill and funded by means of an appropriations bill. Each MILCON project is a line item in the appropriations bill. If the President signs the bill, each of the included projects is funded for five years.

Once funding for the project is received, the construction contract can be awarded. When the awarded contractor has been given a Notice to Proceed, construction of the facility may begin. Typically, this is about four years after the initial request for the facility was made.

2.2 Project Definition

Project Definition was initiated by the Air Force in 1990 to improve the facility end user's satisfaction with the product provided and to reduce changes throughout the construction project. Prior to this, the requesting organization was sometimes not involved in the planning process, and occasionally there was little interaction between the facility user and the facility designer. This resulted in numerous design and construction changes, meaning extensive time delays, huge cost increases, and a facility user or base commander that was not always satisfied with the final product.

Realizing that the best time to gather design inputs, discuss alternatives, and make changes was at the beginning of the project, the Air Force made the decision to change the MILCON process. Figure 2.2 illustrates the relationship between project costs and the ability to influence the project over time (CII Pub.'s 39-1 and 39-2). The Project Definition phase was added to provide a forum in which all project team members, including the facility user, the decision maker, and facility designer, could readily exchange design information at the earliest point possible in the project. The following paragraphs offer a brief explanation of Project Definition as summarized from *The U.S. Air Force Project Manager's Guide to Project Definition* (1994).



NOTE: **Alphanumeric**--Project time period in which the design consists only of written descriptions and quanitities.
Drawing--Project time period in which the design descriptions are translated into working drawings.
Construction--Project time period in which the facility is constructed.
Occupancy--Time period in which the facility user has begun to use the facility for its intended purpose.

Figure 2.2
Influence and Expenditures Curve for the Project Life Cycle

As shown in Figure 2.1, Project Definition begins at the predefinition conference with the selected Architect-Engineer (A-E) or in-house designer and ends when the A-E has presented a preliminary design and a parametric cost estimate. It normally involves two phases: a requirements analysis phase and a schematic design phase. Project Definition typically lasts four to twelve weeks, depending on the complexity of the project. A normal Project Definition schedule, lasting eight weeks, is shown in Figure 2.3 (USAF CE 1994).

To adequately bring all design requirements into consideration, Project Definition must involve many different people with differing interests in the project. The core group of individuals that must execute Project Definition are known as the Project Management Team (PMT). The PMT usually includes the Air Force Project

<table>
<tr><th></th><th>Monday</th><th>Tuesday</th><th>Wednesday</th><th>Thursday</th><th>Friday</th></tr>
<tr><td>Week 1</td><td colspan="2">A-E distributes questionnaire.</td><td colspan="3">Users complete questionnaire.
A-E researches building type.</td></tr>
<tr><td>Week 2</td><td colspan="5">A-E compiles data from questionnaire and conducts interviews and site visits.</td></tr>
<tr><td>Week 3</td><td>A-E conducts on-site analysis</td><td colspan="3">CHARRETTE</td><td>A-E conducts on-site design</td></tr>
<tr><td>Week 4</td><td colspan="5" rowspan="2">A-E produces Project Definition documents including parametric cost estimate.</td></tr>
<tr><td>Week 5</td></tr>
<tr><td>Week 6</td><td colspan="5" rowspan="2">Project Team reviews Project Definition Package.</td></tr>
<tr><td>Week 7</td></tr>
<tr><td>Week 8</td><td colspan="4">A-E finalizes Project Definition Package.</td><td>A-E presents to HRPWC.</td></tr>
</table>

Figure 2.3
Normal Project Definition Schedule

Manager, the Users' Representative, the Design Agent, the base Contracting Officer, the Base Civil Engineering Representative, and the A-E. Other organizations on the base which also participate in Project Definition in varying degrees are known as the Base Support Team, and they normally include the Security Police, the Communications Squadron, the base Fire Department, Environmental Management, the Safety Office, and Base Operations. Organizations not directly associated with the base, known as Outside Agencies, may also influence the process and may include the local or state historical/cultural agencies, the state or federal Environmental Protection Agency, utility companies, and other regulatory agencies. Finally, the project decision maker, known as the Highest Ranking Person With Concern (HRPWC), must also be involved in the process for it to be successful.

The portion of the Project Definition phase in which the A-E, facility user, and the rest of the PMT meet and discuss the project requirements is known as the *charrette*. The purpose of the charrette is to fully develop and quantify the functional

and technical requirements of the project. For normal-sized projects, the charrette lasts one week; for complex projects, two separate charrettes for analysis and design may be required. Although the A-E leads the charrettes, the Air Force Project Manager must ensure the charrette stays on schedule and that all necessary personnel are involved in the process.

Project Definition consists of two phases. The first of these phases is the *requirements analysis* phase, also known as *programming* in most architectural design schedules. In this phase, the A-E distributes questionnaires, makes visits, conducts research and interviews, and performs any necessary site, geotechnical, or environmental investigations. Prior to the start of the charrette, the A-E produces summaries, graphic displays, and question sheets so space and requirements issues come to the front during the charrette meetings. The requirements analysis charrette produces products which are alphanumeric in nature: goal statements, tabulated space projections, analysis cards of project issues, site analysis cards, environmental concerns, affinity matrices, area summaries, flow charts, bubble diagrams, value engineering opportunities, cost estimates, and site photographs. The desire of the Air Force is for the PMT to reach a consensus regarding the project requirements during the analysis portion of the charrette. As shown in Figure 2.2, it is relatively easy and inexpensive to change requirements while the project is still in the alphanumeric stage.

The second phase of Project Definition is the *schematic design* phase. Once agreement has been reached concerning the project requirements, the A-E, with the participation of the rest of the PMT, begins to create a schematic solution. The design charrette involves exploring options and design alternatives, and eventually reaching a consensus on a schematic design. The detail to which the project is designed is not strictly governed. Some building systems such as the floor plan may be designed to 50%, while others such as the electrical system may only be designed to 5%. It is critical that all members of the PMT be present during this phase and that the HRPWC

is briefed regularly on the layout of the facility. Also critical is the presence of the cost estimator. It is the estimator's responsibility to provide cost estimates for all design alternatives as they are being discussed and to make suggestions on how to lower the initial and operating costs; this is to keep the project from exceeding its programmed budget. Products of the design charrette normally include a site development plan, a schematic floor plan, furniture and equipment layouts, building area tabulations, exterior building elevation drawings, base comprehensive plan conformance, building sections, building subsystem cost analysis/value engineering, design criteria and selected building systems narrative, the parametric cost estimate, an operability and maintainability report, and an environmental checklist.

Following the charrettes, the A-E compiles all design decisions into a Project Definition Package. This package is presented in a notebook format and includes such things as a project description, site development and floor plans, narratives, environmental concerns, and the cost estimate. The final act of the A-E during Project Definition is to brief the HRPWC on the preliminary design and parametric cost estimate. By doing so, the project's design is "cast in concrete" and later changes are reduced.

2.3 The U.S. Air Force Center for Environmental Excellence

The research for this thesis was done for and in cooperation with the U.S. Air Force Center for Environmental Excellence (AFCEE), located at Brooks Air Force Base, Texas. AFCEE was created in 1991 to ensure environmental and facility excellence for the U.S. Air Force (AFCEE 1994). While the majority of the AFCEE functions involve Air Force environmental concerns, they also include a branch solely devoted to construction management. AFCEE's Construction Management Office manages construction projects for several of the Air Force's smaller Major Commands. As of the date of this thesis, the construction projects AFCEE manages

constitute approximately 40% of the total number of Air Force housing construction projects, 8% of the Base Realignment and Closure projects, and 20% of regular military construction. The other Air Force construction projects are managed by the larger commands, including Air Combat Command, Air Mobility Command, Air Education and Training Command, and Air Force Materiel Command. While this research only examines twenty-five projects managed by AFCEE, the results should also apply to the other Major Commands as well since Project Definition is an Air Force-wide initiative.

2.4 The Construction Industry Institute's Pre-Project Planning Research

The Construction Industry Institute (CII), located in Austin, Texas is a consortium made up of approximately ninety owners and construction contractors and includes private firms as well as government organizations. The stated goal of CII is: *to improve the total quality and cost effectiveness of the construction industry, thereby providing a competitive advantage for U.S. business in the global marketplace* (CII 1991). CII accomplishes its goal by funding construction research through the University of Texas at Austin and other universities throughout the United States. One of CII's major research efforts was the study of the effort and subsequent payoff of up-front project planning, known as Pre-Project Planning (P^3). This research was extensive and resulted in the development of CII Publication 39-2, the *Pre-Project Planning Handbook.*

The CII research team defined pre-project planning as *the process of developing sufficient strategic information with which owners can address risk and decide to commit resources to maximize the chance for a successful project* (CII Pub 39-2). Through its research, CII defined the four major functions and sub-functions of pre-project planning to be the following:

1. Organize for Pre-Project Planning
    a. Select Team
    b. Draft Charter
    c. Prepare Pre-Project Planning Plan
2. Select Project Alternative(s)
    a. Analyze Technology
    b. Evaluate Site(s)
    c. Prepare Conceptual Scopes and Estimates
    d. Evaluate Alternatives
3. Develop a Project Definition Package
    a. Analyze Project Risks
    b. Document Project Scope and Design
    c. Define Project Execution Approach
    d. Establish Project Control Guidelines
    e. Compile Project Definition Package
4. Decide Whether to Proceed with Project
    a. Make Decision

To validate the need for pre-project planning, CII conducted a study of sixty-two projects and compared the level of pre-project planning effort and project success for each project. The study produced conclusive evidence that a definite correlation between pre-project planning effort and the level of project success does exist; the greater the pre-project planning effort, the greater the success of the project. The research team also calculated a conservative estimate of 20% savings versus authorization estimate by consistently performing pre-project planning versus performing very little pre-project planning (CII Pub. 39-1).

In the development of this thesis, the author compared the CII P^3 Model with the new Air Force MILCON process. It is the opinion of the author that the new

MILCON process contains every element of the CII P^3 Model. The Air Force's Requirements and Management Plan satisfies the first of the CII pre-project planning functions by naming the project management team and stating project strategic decisions. During Project Definition, the Air Force evaluates and selects alternatives, and the A-E prepares the project definition package. Finally, when Project Definition is complete and a preliminary design and cost estimate are achieved, the Air Force, Department of Defense, and U.S. Congress, with information produced during Project Definition, decide whether or not to proceed with the project. If executed effectively, the new Air Force MILCON process should produce savings comparable to those of the CII companies.

2.5 The Construction Industry Institute's Metrics and Benchmarking Research

CII has defined the term *metric* as being a quantifiable, simple and understandable measure which can be used to optimize performance. The term *benchmarking* is defined as a continuous process of improvement or the search for industry practices that lead to superior performance (Tucker 1995). In other words, metrics are indicators of performance, while benchmarking is the process by which performance is improved. The U.S. Air Force has defined the eight attributes of a good metric as the following (AFSC 1990):

1. It is accepted as meaningful to the customer.
2. It tells how well an organization's processes and tasks fulfill its goals and objectives.
3. It is simple, understandable, logical, and repeatable.
4. It shows a trend.
5. It is unambiguously defined.
6. Its data is economical to collect.
7. It is timely.
8. It drives the "appropriate action."

The CII Benchmarking and Metrics Committee is currently attempting to define metrics that can be applied to the entire construction industry. To organize the

many metrics relating to the construction industry, the committee created a tier system, as shown in Figure 2.4 (CII B&M 1995). The research conducted for this thesis included the development of metrics for the Air Force's Project Definition Phase. In comparison to the CII Metrics Tiers, the Project Definition metrics would be considered Tier III metrics since this phase is only one step within the Air Force's project planning system.

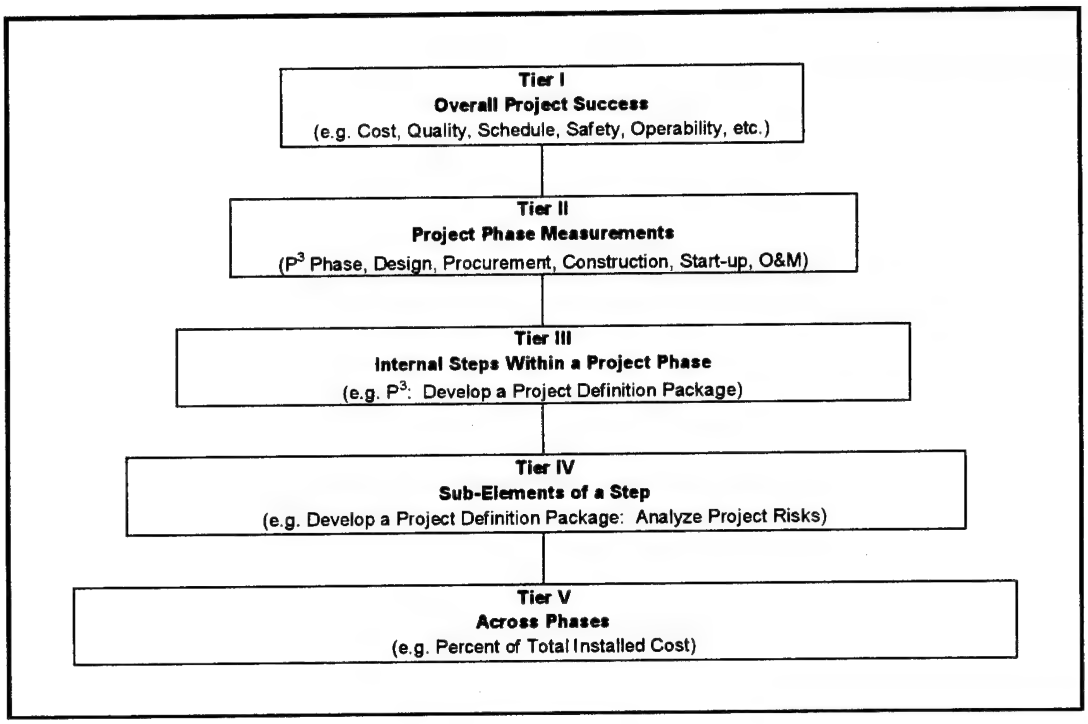


Figure 2.4
CII Metrics Tiers

2.6 Other Background Sources

Several other sources were reviewed by the author in preparation of this thesis. The full titles of the following sources are listed in the Bibliography. Dr. James Broaddus's dissertation (1991) contains a study of fifty-five U.S. Navy construction projects and compared the level of up-front planning and subsequent project success.

As with the CII Pre-Project Planning study, the Broaddus study shows conclusively that a direct, positive correlation exists between the level of pre-project planning and project success. Aniello Tortura's thesis (1993) and Dr. Michele Hamilton's dissertation (1994) each support different aspects of the CII Pre-Project Planning research previously described. Finally, Steven Davis's thesis (1993) includes a study of twenty-two Air Force projects, and like the CII and Broaddus studies, it shows the correlation between planning effort and project success.

3.0 Methodology

3.1 Metrics

As discussed in the previous chapter, to study the effectiveness of Project Definition, metrics were developed to give an indication of performance. The metrics which measure the outcome of the design effort are generally related to the following: the cost estimate vs. the actual cost, the cost of the Project Definition and design efforts, the impact of design changes on the design schedule, and customer satisfaction. However, to fully evaluate Project Definition, not only were the outputs of the design phase measured, the inputs were measured as well. The measurement of each of these metrics will be discussed in the following sections.

3.2 Objectives Matrix

To stay within the limits of this thesis, it was necessary to produce a single Project Definition input and Design outcome rating for each project. In order to measure the performance of several different metrics and still have only one input and output rating per project, an objectives matrix was used to produce a numerical performance index. The objectives matrix allows the flexibility to combine a variety of criteria, weights, measuring systems and performance ratings into a single performance index (CII Pub. 8-1). Specifically, this method allows both subjective measures (such as customer satisfaction) and objective measures (such as estimate vs. actual) to be combined numerically. The objectives matrix works by scoring each criterion on a scale of 1 to 10 and then multiplying this score by the criterion's assigned weight, producing a numerical value for each criterion. After each criterion's value is calculated, all of the values are added to produce the index for one project.

3.2.1 Development of Matrices

The hypothesis of this thesis is that if the Project Management Team effectively follows the Project Definition process, a more successful design effort will result. By measuring both inputs to and outputs of the process, a *Project Definition Index* and a *Design Success Index* for each project was produced. Assigning these indices (rated from 0 to 1000) as axes on a graph produces a single point for each project (see Figure 3.1). Plotting all twenty-five projects on the same graph should provide an indication of whether Project Definition is achieving its desired purposes. Ideally, a diagonal line from the 0,0 point to the 1000,1000 point will result, indicating that lower rated inputs into the design process produce lower output ratings and higher inputs produce higher outputs. This means that those projects to which the Project Definition process is effectively applied will have more successful design efforts.

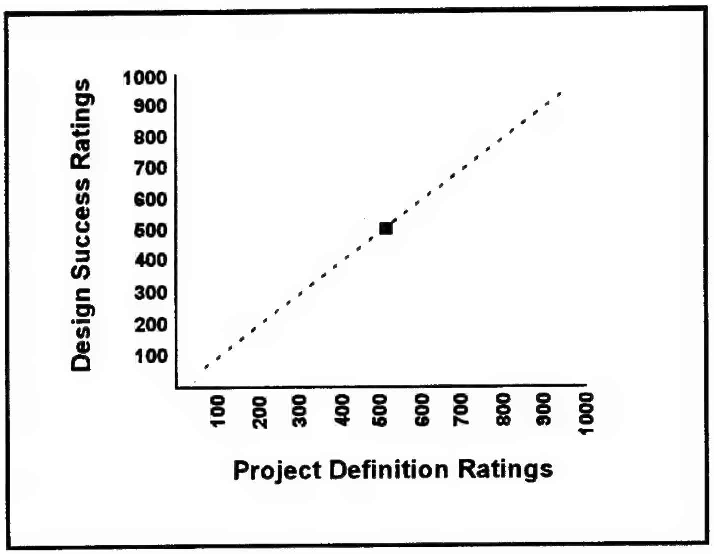


Figure 3.1
Expected Results Graph

Management personnel at the AFCEE Construction Management Office and the author met several times over a two month period to discuss the development of the input and output matrices used in this study. For measurement of the inputs to

Project Definition, based on the *United States Air Force Project Manager's Guide to Project Definition* the author suggested several factors to the AFCEE managers. These factors primarily dealt with the people involved in the process, the products of the process, as well as the process itself. The AFCEE managers refined the list of input criteria, and the Project Definition Matrix was formed. Since the list of input criteria is extensive, the criteria were broken down into three sub-matrices: the Project Management Team, the Project Definition Process, and the Project Definition Products.

For the output matrix (Design Success Matrix), several possible metrics were discussed for inclusion in the study. The primary source of measurement information came from the AFCEE managers' experience with military construction. The AFCEE personnel were primarily concerned about design changes, the cost of these changes, and the impact changes had on the project schedule. They were also concerned about the level of customer satisfaction with the new MILCON process. These metrics were refined and formed the basis of the Design Success Matrix and Customer Satisfaction Sub-Matrix.

The criteria on the matrices were weighted by the deputy director of the AFCEE Construction Management Office and the chief of the Reserve Division of the AFCEE Construction Management Office. As the matrices were revised during the two months of meetings and discussion, the weights assigned to the criteria were also revised.

3.2.2 Organization of Matrices

The general organization of the matrices is shown in Figure 3.2. The Project Definition Matrix and its sub-matrices are shown in Figures 3.3 to 3.6. The Design Success Matrix and Customer Satisfaction Sub-Matrix are shown in Figures 3.7

and 3.8. The Definitions of the different criteria for each matrix are provided in the figures.

On the Design Success Matrix, one criterion, the "Cost of Design", had two different scoring scales. For projects ranging from \$1.0-5.0 Million, the median rating (5) for "Cost of Design" was 9.5% of the total budget (as shown in Figure 3.7), while projects with a total budget greater than \$5.0 Million were scored with the median rating being 6.5%. This was done to ensure that all of the projects were treated on an equal basis. The two median values (9.5% and 6.5%) were used since these were the Corps of Engineers accepted standards for Cost of Design for these sizes of projects.

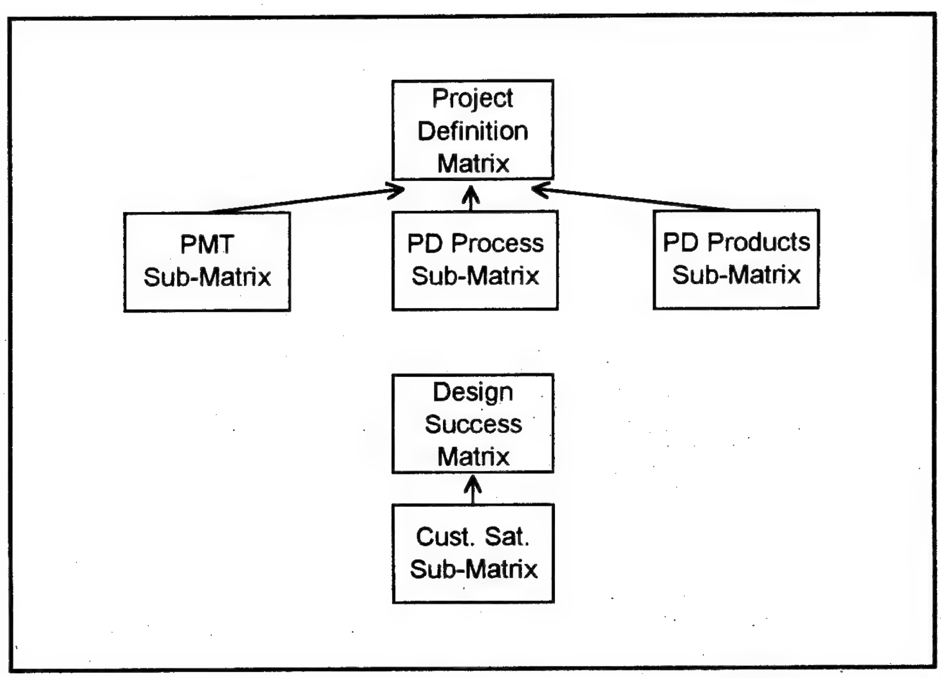


Figure 3.2
Organization of Matrices

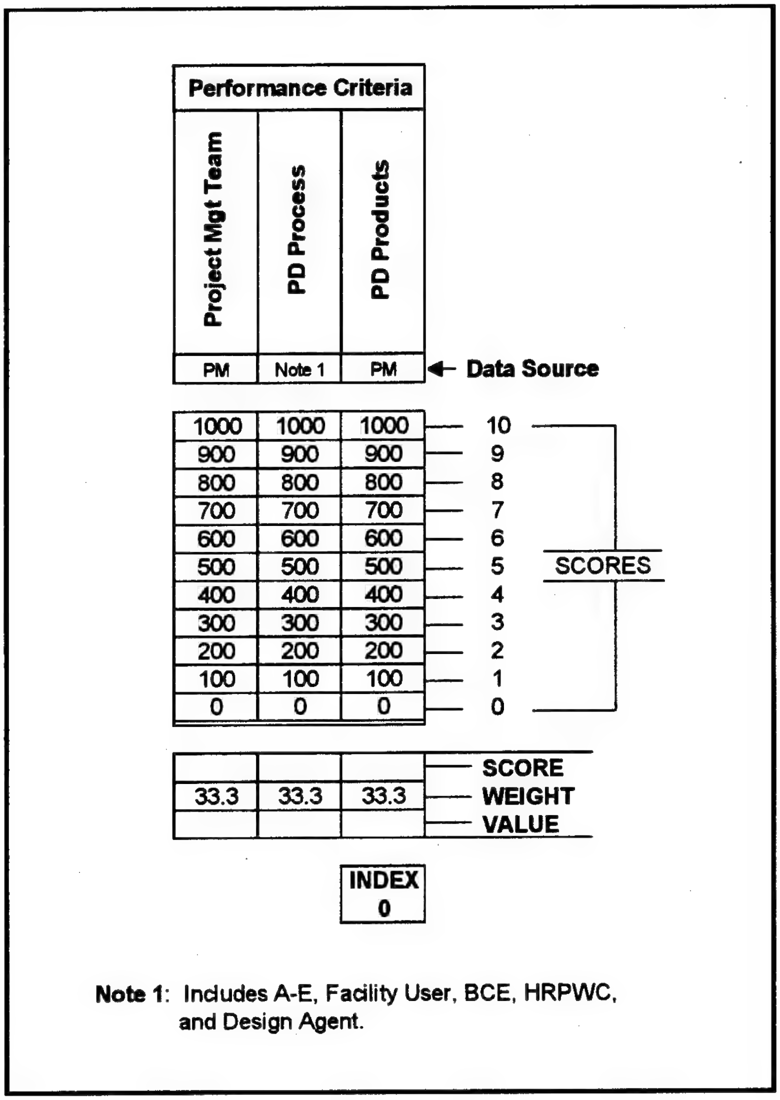


Figure 3.3
Project Definition Matrix

Performance Criteria										
A-E	Cost Estimator	Design Agent	Facility User	HRPWC/Decision Maker	BCE	MAJCOM	Base Support	Outside Agencies	Project Manager	
PM	PM	PM	PM	PM	PM	PM	PM	PM	PM	← Data Source
										10
										9
										8
										7
										6
										5 SCORES
										4
										3
										2
										1
										0
										SCORE
25	5	5	10	10	8	5	7	5	20	WEIGHT
										VALUE

INDEX
0

Definitions:

A-E: Architect-Engineer firm or in-house design team chosen to execute Project Definition
Cost Estimator: Professional cost estimator employed by A-E to provide the parametric cost estimate (PCE) for the project.
Design Agent: Corps of Engineers, NAVFAC, or Air Force
Facility User: USAF Facility End User/Future Occupant
HRPWC/Decision Maker: USAF Highest Ranking Person With Concern
BCE: USAF Base Civil Engineering staff
MAJCOM: The major command responsible for the project.
Base Support: Any other on-base organizations with input into the project.
Outside Agencies: Non-military organizations with input into the project (i.e. EPA, Utilities).
Project Manager: USAF Project Manager

Figure 3.4
Project Management Team Sub-Matrix

Performance Criteria								
User Req'ts Defined	Project Goals Defined	PD Process Explained	Design Alternatives Considered	Consensus Reached	Right People Involved	Charrette	Library Wall	
Note 1	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1	← Data Source

								SCORES
								10
								9
								8
								7
								6
								5
								4
								3
								2
								1
								0

								SCORE
30	5	5	5	25	10	15	5	WEIGHT
								VALUE

INDEX
0

Definitions:

User Req'ts Defined: how well user's requirements defined during PD.
Project Goals Defined: how well project goals identified before design started.
PD Process Explained: how well the PD process was communicated.
Design Alternatives Considered: the degree to which design alternatives were considered.
Consensus Reached: how well the team agreed on the selected design alternatives.
Right People Involved: the degree to which the right people involved in the process.
Charrette: how well the team conferences produced a satisfied customer, lower cost, and reduced schedule.
Library Wall: how effective the temporary wall display of information was in communicating design requirements and decisions.
Note 1: Includes A-E, BCE, Facility User, HRPWC and Design Agent.

Figure 3.5
Project Definition Process Sub-Matrix

Performance Criteria									
Project Mgt Plan	Pre-Definition Conf.	Data Gathering/ Req'ts Analysis	Site Plan	Floor Plan	Building Sub-Systems	Elevations	Cost Estimate	Environmental Checklist	
PM	PM	PM	PM	PM	PM	PM	PM	PM	← Data Source
									10
									9
									8
									7
									6
									5 SCORES
									4
									3
									2
									1
									0

									SCORE
5	10	15	15	20	10	5	15	5	WEIGHT
									VALUE

INDEX
0

Definitions:

Project Management Plan: communicates strategic decisions and defines project team.
Pre-Definition Conf: conference with A-E that reviews scope, requirements, standards, etc.
Data Gathering/Req'ts Analysis: portion of PD that produces design requirements information.
Site Plan: drawing that depicts site requirements, including utilities, contours, and parking.
Floor Plan: drawing that depicts facility interior space requirements.
Building Sub-Systems: narratives that describe sub-systems such as walls, HVAC, comm, etc.
Elevations: drawings that depict exterior appearance.
Cost Estimate: the parametric cost estimate developed during PD.
Environmental Checklist: list of critical environmental issues that the team should consider.

Figure 3.6
Project Definition Products Sub-Matrix

Performance Criteria								
100% Estimate vs. PCE	Bid Cost vs. PCE	100% Estimate vs. Programmed Amount	Cost of Changes During Design	Cost of Project Definition Effort	Cost of Design	Impact of Changes on Design Schedule	Customer Satisfaction	
PM	PM	PM	PM	PM	PM	PM	Note 1	← Data Source
0	0	0	0	0.2	4.5	0	1000	10
1	1	1	1	0.7	5.5	1	900	9
2	2	2	2	1.2	6.5	2	800	8
3	3	3	3	1.7	7.5	3	700	7
4	4	4	4	2.2	8.5	4	600	6
5	5	5	5	2.7	9.5	5	500	5 SCORES
6	6	6	7	3.2	10.5	7	400	4
7	7	7	10	3.7	11.5	10	300	3
8	8	8	15	4.2	12.5	14	200	2
9	9	9	20	4.7	13.5	17	100	1
10+	10+	10+	25+	5.2+	14.5+	20+	0	0
								SCORE
15	20	10	15	5	5	5	25	WEIGHT
								VALUE

INDEX
0

Definitions:

100% Estimate vs. PCE: The percentage of change between the cost estimate developed during Project Definition and the estimate at Design Complete.

Bid Cost vs. PCE: The percentage of change between the parametric cost estimate developed during Project Definition and the bid cost of the project.

100% Estimate vs. Programmed amount: The percentage of change between the amount originally budgeted and the cost estimate at Design Complete.

Cost of Changes During Design: Percent of budget spent on Air Force-directed changes.

Cost of Project Definition Effort: Percent of budget spent on the Project Definition phase.

Cost of Design: Percent of budget spent on the Design phase (including PD).

Impact of Changes on Schedule: The percentage of total design time that was spent on Air Force-directed design changes.

Note 1: Includes Facility User, BCE, and HRPWC (see Customer Sat. sub-matrix)

Figure 3.7
Design Success Matrix

Performance Criteria						
Satisfied with Process	HRPWC Involvement	Meets Mission Needs	Functionality	Maintability	Aesthetics	
Note 1	HRPWC	Note 2	User	BCE	BCE	← Data Source

						10	SCORES
						9	
						8	
						7	
						6	
						5	
						4	
						3	
						2	
						1	
						0	

						SCORE
10	10	25	25	15	15	WEIGHT
						VALUE

INDEX
0

Definitions:

Satisfied with Process: Rating of satisfaction with PD process.
HRPWC Involvement: Decision maker's satisfaction with his/her involvement.
Meets Mission Needs of Organization: Degree to which facility will meet the mission needs of the using organization and the base.
Functionality: The design of the facility will enhance the job effectiveness of the users.
Maintainability: Compared with other facilities of this type, this facility will be easy to maintain.
Aesthetics: The facility will fit in well with the architectural scheme of the base.
Note 1: Includes all survey interviewees.
Note 2: Includes Facility End User and HRPWC.

Figure 3.8
Customer Satisfaction Sub-Matrix

3.3 Development of Questionnaires

To get direct input for the matrices developed for this research, written questionnaires were created with the guidance of AFCEE personnel. Each question on the survey is a statement about one particular aspect of the project. The interviewee was asked to circle a rating from 1 to 10, indicating his or her agreement or disagreement with each statement. In some cases, additional comments were sought for certain questions, and all interviewees were asked to provide comments or suggestions they had concerning the Project Definition process. Also, the Air Force Project Managers were asked to fill in blanks on their questionnaires so that project execution and cost data could be recorded. The questionnaires used for this research are listed as Appendices 1 through 6. Additionally, the completed matrices for one example project are listed as Appendix 7.

3.4 Data Sources

As shown on the matrices, the data for each criteria came from a variety of project sources. This was done so that the results of the study would not be biased toward any particular project participant group. Specifically, the customer groups provided data on the Project Definition Process and Customer Satisfaction, while the Air Force Project Manager provided data on the Project Management Team, the Project Definition Products, project costs and schedule. AFCEE considers not only the facility user but also other project engineering personnel and the project decision maker to be its customers. The customer group contained both privately employed and government employed personnel, and the government personnel surveyed included both military and civil service personnel. The following is a summary description of the sources that were utilized to gather project performance data:

<u>Air Force Project Manager</u>: for this study, this is the person from AFCEE who manages the Project Definition and Design phases for the Air Force.

Architect-Engineer: this is the project designer and may be a private A-E firm or a team of in-house government personnel. The A-E is required to not only design the facility but also to execute the Project Definition phase, including data gathering, data analysis, charrette execution, and cost estimation.

Base Civil Engineering Staff Representative: this is the person in the local Air Force base civil engineering squadron who is responsible for coordination of the project at his or her base.

Design Agent: usually the U.S. Army Corps of Engineers or U.S. Naval Facilities Engineering Command (NAVFAC); ultimately responsible for the design of the project.

Facility User: the facility end user or future occupant.

Highest Ranking Person With Concern (HRPWC): the project's decision maker; could be either senior ranking military or civil service personnel.

3.5 Projects Studied

The projects chosen for inclusion in this study are listed in Table 3.1. Project Definition on each of these projects was complete, and the construction contract had been awarded, however the construction was not yet complete. This was done so that the information collected about Project Definition was easily remembered by the project participants. This also allowed for an in-depth study into the effects Project Definition has on the design of the project, including the affect design changes had on the design schedule and the variance between cost estimates and actual costs. However, due to the fact that construction was not complete, project construction data could not be collected. This prevented comparing such things as the original cost estimate to the final construction cost and prevented the study of the effects Project Definition has on the final outcome of the project.

TABLE 3.1
LIST OF PROJECT ATTRIBUTES

PROJECT TITLE	LOCATION	BUDGET COST ($K)	DELIVERY STRATEGY	DESIGN AGENT	CHARRETTE
AFCEE Building	Brooks AFB, TX	8,400	Design-bid-build	Air Force	Yes
Fire Training Facility	Vandenberg AFB, CA	1,550	Design-bid-build	Corps	Yes
TPQ-18 Radar Facility	Vandenberg AFB, CA	2,408	Design-bid-build	Corps	Yes
Intell Tech	Fairchild AFB, WA	3,500	Design-bid-build	Corps	No
Underground Storage Tank	Patrick AFB, FL	1,850	Design-build	Corps	No
Underground Fuel Storage	Peterson AFB, CO	1,750	Design-bid-build	Corps	No
Waste Water Treatment Plant	Edwards AFB, CA	19,500	Design-bid-build	Corps	No
Housing	Edwards AFB, CA	13,700	Design-bid-build	Air Force	Yes
Delta Launch Facility	Cape Canaveral, FL	7,000	Design-bid-build	Corps	Yes
Waste Water Treatment Plant	Ascension Island	3,400	Design-bid-build	NAVFAC	No
Organization Maintenance Shop	Peterson AFB, CO	1,200	Design-bid-build	Corps	Yes
Avionics Shop	Peterson AFB, CO	1,300	Design-bid-build	Corps	No
Alter Shops ADAL Aerial Port, Alter Maintenance Hangar, Alter Various Facilities, Ops/Admin	Wright-Patterson AFB, OH	10,700	Design-bid-build	Corps	Yes
Corrosion Control/Fuel System Maint.	Hill AFB, UT	1,000	Design-bid-build	Corps	No
Interoperability Test	Scott AFB, IL	5,000	Design-bid-build	Corps	Yes
Child Development Center	Air Force Academy	4,200	Design-bid-build	Corps	Yes
ANG-Aircraft Shelter	Homestead AFB, FL	2,000	Design-bid-build	Corps	Yes
Medical Training Facility	Homestead AFB, FL	2,750	Design-bid-build	Corps	Yes
Repair Dormitory	Homestead AFB, FL	3,100	Design-bid-build	Corps	Yes
Composite	Whiteman AFB, MO	4,460	Design-bid-build	Corps	No
Munitions	Whiteman AFB, MO	3,080	Design-bid-build	Corps	No
Flight Simulator	Dobbins AFB, GA	6,000	Design-bid-build	Corps	Yes
RED HORSE Structural Utility Facility	Kelly AFB, TX	2,300	Design-bid-build	Corps	No
F-16 Beddown	New Orleans NAS, LA	8,200	Design-bid-build	NAVFAC	Yes
Housing	Barksdale AFB, LA	16,820	Design-bid-build	Air Force	Yes

4.0 Presentation and Analysis of Results

4.1 Questionnaire Response

Originally, thirty-one projects were chosen for inclusion in this study, with 186 questionnaires sent to project participants (six participants per project). Of the questionnaires distributed, 146 were returned. However, due to lack of information or non-conformity with the purpose of this thesis, six projects were eliminated from the study. This left twenty-five projects that were included in the final tabulation of results and analysis.

4.2 Project Definition Ratings versus Design Success Ratings

As stated in Chapters 1 and 3, this study hypothesized that those projects to which the Project Definition process was effectively applied would have more successful design efforts than those projects to which the process was not effectively applied. When the questionnaire responses for this study were compiled, the matrices were used to produce ratings, or indices, as shown in Chapter 3. This produced a *Project Definition Index* and a *Design Success Index* for all twenty-five projects.

Microsoft Excel software was used to tabulate and plot the data in graphic format. Excel produced a *line of best fit*, calculating the equation of this line using linear regression. The R^2 value was also calculated by the Excel software, indicating the reliability of the line of best fit. The scatter plot of the Project Definition and Design Success indices and the line of best fit are shown in Figure 4.1.

The plot shows that a positive correlation exists between Project Definition effort and Design Success effort. This indicates that, on average, higher Project Definition Indices produce higher Design Success Indices. In practical terms, this means that when the entire Project Management Team meets on-site to discuss project

objectives, goals, and requirements, and works to produce a preliminary design, cost estimate, and written narratives, then a design phase with less cost variance (between estimated and actual), less design changes, less design cost, less schedule variance, and greater customer satisfaction will result.

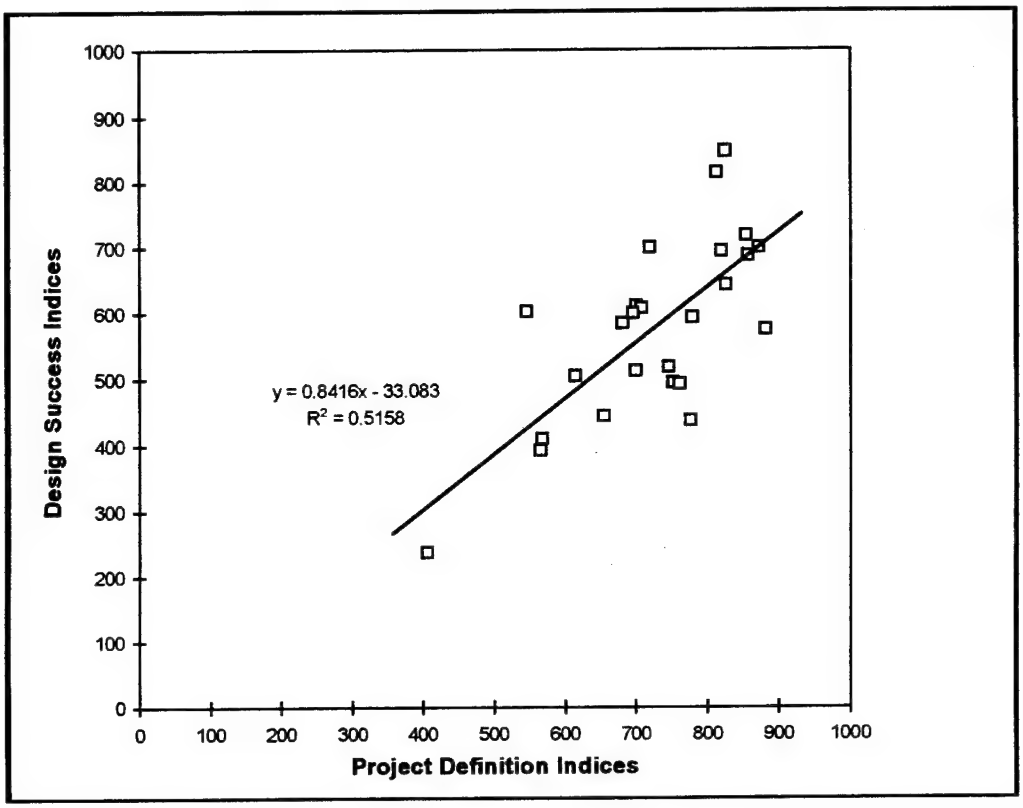


Figure 4.1
Project Definition v. Design Success

As can be seen in Figure 4.1, the line of best fit has a slope approximately equal to 0.84 and intercepts the y-axis at slightly less than zero. This indicates that an approximate one-to-one relationship exists between Project Definition effort and Design Success. The $R^2 = 0.5158$ indicates that the line of best fit is a reliable representation of the relationship between the independent variable, Project Definition, and the dependent variable, Design Success. Typically, R^2 values greater than 0.5

indicate a strong correlation exists between the independent and dependent variables (Ingram 1977). However, it should be noted that this strong correlation does not statistically prove a cause and effect relationship. Also apparent on the graph shown in Figure 4.1 is the "right-sidedness" of the plotted points, indicating that in all but one of the projects studied, the Project Definition Indices were above 500. Since the score of "5" was considered average on the matrices, this indicates that these projects had above average ratings for the Project Management Team, Project Definition Products, and Project Definition Process. The Design Success ratings were more varied, ranging from a low of 238 to a high of 848.

After the six indices (see Figures 3.2-3.8) for all twenty-five projects were calculated, average values were calculated. The average Project Definition Index was 725, with the average Project Management Team Index being 691, the average Products Index being 724, and the average Process Index being 762. The average Design Success Index for all projects was 577, with the average Customer Satisfaction Index being 812.

4.3 Comparison of Projects With Charrettes and Projects Without Charrettes

As described in Chapter 2, the *charrette* is the one or two-week long meeting where the Project Management Team gathers to discuss requirements and make design decisions. It is the central focus of the new MILCON process and is expected to improve teamwork as well as overall design success. For this study, of the twenty-five projects studied, fifteen of the projects had charrettes during the Project Definition phase and ten did not have charrettes. An in-depth analysis of the data provides evidence that on those projects where the participants met at a charrette, more accurate and complete preliminary designs and estimates were gained. Figure 4.2 is a summary of the comparison of those projects that had charrettes and those that did not. The Design Success Metrics are the same criteria that were used in the Design

Success Matrix (see Figure 3.7). It is notable that the projects having charrettes out-performed, in every success metric, those that did not.

Design Success Metrics	Mean Values (%) All**	Mean Values (%) Charrette	Mean Values (%) No Charrette	P (T<=t) two tail
100% Est v. PCE:	12.40	8.07	18.90	0.0903
Bid Cost v. PCE:	15.79	13.29	19.30	0.4608
100% Ext v. PA:	9.32	7.13	12.60	0.3140
Cost of Changes:	0.76	0.60	1.00	0.5113
Cost of PD:	2.30	2.07	2.61	0.2986
Cost of Design(<$5M)*:	11.41	11.38	11.44	0.9822
Cost of Design (>$5M)*:	8.75	7.86	15.00	0.0620
Impact of Changes:	6.25	5.00	8.00	0.5000
Customer Satisfaction:	812	827	791	0.4121

NOTE: * Includes cost of PD (17 projects ≤$5M, 8 projects >$5M).
** 15 projects had charrettes, 10 projects did not have charrettes.

Definitions:

100% Estimate vs. PCE: The percentage of change between the cost estimate developed during Project Definition and the estimate at Design Complete.

Bid Cost vs. PCE: The percentage of change between the parametric cost estimate developed during Project Definition and the bid cost of the project.

100% Estimate vs. Programmed amount: The percentage of change between the amount originally budgeted and the cost estimate at Design Complete.

Cost of Changes During Design: Percent of budget spent on Air Force-directed changes.

Cost of Project Definition Effort: Percent of budget spent on the Project Definition phase.

Cost of Design: Percent of budget spent on the Design phase (including PD).

Impact of Changes on Schedule: The percentage of total design time that was spent on Air Force-directed design changes.

Customer Satisfaction: Index from sub-matrix; rated from 0 to 1000.

Figure 4.2
Performance Comparison of Projects With Charrettes and Projects Without Charrettes

The last column in Figure 4.2 shows the results of a *t* test for the charrette and non-charrette means shown. The null hypothesis was that the sample means for the charrette and non-charrette proejcts are equal using a significance of 0.10 due to the

small sample sizes. The last column gives the probability that the sample means are equal for the each criterion. The results of the *t* test indicate that the null hypothesis can only be rejected for the *100% Estimate v. Parametric Cost Estimate* and the *Cost of Design for Projects Greater than $5 Million* criteria. This indicates that the rest of the criteria are statistically similar and that the comparison of the means can not be taken as statistically conclusive evidence. However, by inspection of the entire table in Figure 4.2, it can generally be concluded that the projects that had charrettes performed better than those projects that did not have charrettes.

The sample variances for the Design Success Metrics for the projects with charrettes and projects without charrettes are shown in Figure 4.3. Inspection of this figure shows that, for the most part, those projects that had charrettes appeared to perform much more consistently than the projects that did not have charrettes.

	Sample Variances	
Design Success Metrics	**Charrette**	**No Charrette**
100% Est v. PCE:	61.78	479.66
Bid Cost v. PCE:	181.76	652.68
100% Ext v. PA:	92.27	288.93
Cost of Changes:	1.40	3.33
Cost of PD:	0.88	2.37
Cost of Design(≤$5M)*:	14.27	61.53
Cost of Design (>$5M)*:	18.81	0.00
Impact of Changes:	134.62	78.44
Customer Satisfaction:	10240.21	12125.56

Figure 4.3
Comparison of Variances

Comparing the matrix performance ratings of projects with charrettes and those without charrettes also shows that charrettes produce higher ratings. Figures 4.4 and 4.5 highlight this fact.

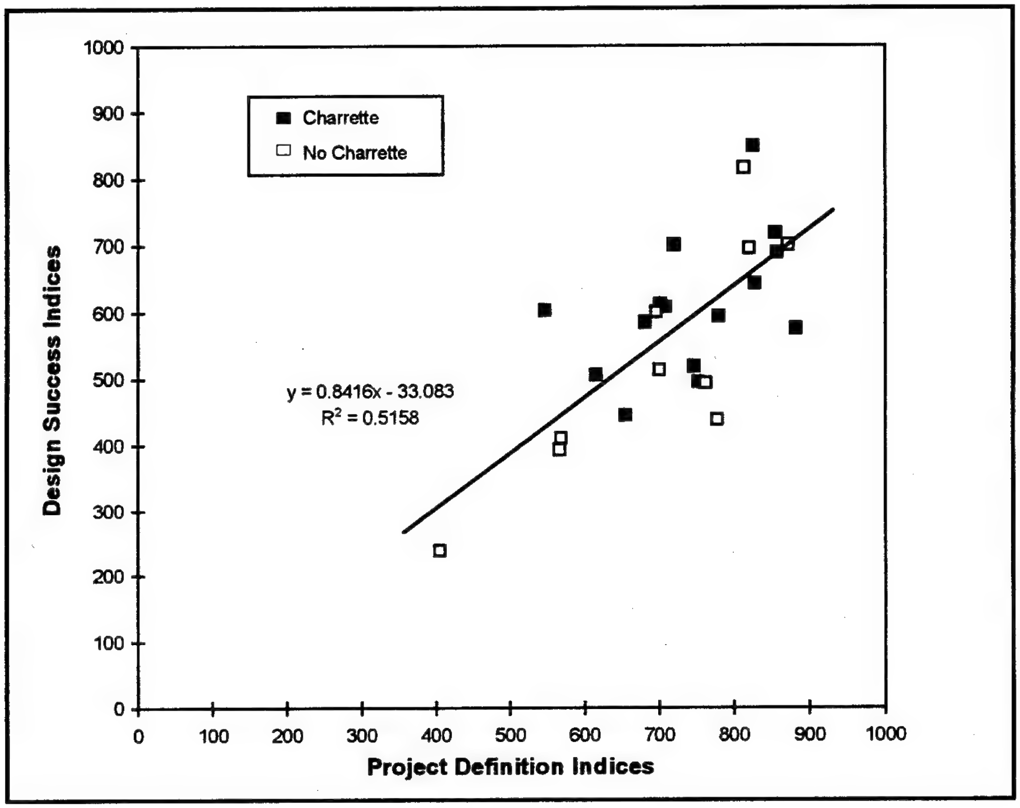


Figure 4.4
Project Definition v. Design Success
(Charrette Projects Highlighted)

	PD Index	Design Index	PMT Index	Products Index	Process Index	Cust Sat Index
Ave--all	725	577	691	724	762	812
Ave--charrette	743	609	724	743	765	827
Ave--no charrette	698	530	642	696	759	791

Figure 4.5
Summary of Average Indices

As shown in Figures 4.4 and 4.5, the average values of the matrix indices are higher for those projects with charrettes. Particularly noteworthy is the difference between the average values for the Design Success Index (609 v. 530). Additionally, the three highest non-charrette projects all had significant on-site site data gathering and on-site design analysis, although they did not have charrettes. If these three

projects are taken out of the calculation, the average Design Success Index for projects not having charrettes drops from 530 to 441.

4.4 Analysis of Selected Survey Questions

Although all questions asked on the research questionnaires were used in the calculation of the matrix indices, a few of the questions have been selected for further analysis. These questions were chosen due to the relative weight on the matrices assigned to them by AFCEE. The following are the questions and the average responses to them:

Question: *The A-E firm/in-house design team chosen to conduct the charrettes during the Project Definition phase of this project was well prepared and effectively led the on-site analysis and design required by the contract.*
Average Rating by USAF Project Manager: 6.82 (Slightly Agree)

Question: *As the Air Force Project Manager, I feel I was effective in bringing the Project Management Team to consensus.*
Average Rating by USAF Project Manager: 7.42 (Agree)

Question: *The Schematic Floor Plan developed during Project Definition satisfied the user by adequately depicting all space requirements of the facility.*
Average Rating by USAF Project Manager: 8.00 (Agree)

Question: *The facility user's requirements were clearly defined during Project Definition.*
Average Rating by A-E, BCE, Design Agent, User, & HRPWC: 8.08 (Agree)

Question: *A consensus was reached among project team members on selected design alternatives and building sub-systems.*
Average Rating by A-E, BCE, Design Agent, & User: 7.81 (Agree)

Question: *I was satisfied with my involvement in the final design decisions made during Project Definition.*
Average Rating by HRPWC: 8.58 (Agree)

Question: *This facility will enhance the mission effectiveness of the base/organization.*
Average Rating by User & HRPWC: 8.88 (Strongly Agree—Agree)

Question: *This facility will enhance the job effectiveness of the personnel in my organization.*
Average Rating by User: 8.39 (Agree)

Question: *I was satisfied with the Project Definition process, because I believe the process enhanced the final product.*
Average Rating by All Project Participants: 7.66 (Agree)
This question was also averaged by participant group:
Average Rating by A-E: 8.32 (Agree)
Average Rating by BCE: 7.53 (Agree)
Average Rating by Design Agent: 7.83 (Agree)
Average Rating by User: 7.05 (Agree— Slightly Agree)
Average Rating by HRPWC: 8.74 (Strongly Agree—Agree)
Average Rating by USAF Project Manager: 7.08 (Agree—Slightly Agree)

4.5 Participants' Comments and Suggestions

On each questionnaire, project participants were asked to provide comments and/or suggestions they had on improving the Project Definition process. These comments are listed in Appendices 8 through 13. Many of the survey respondents provided comments pertaining to a specific project, but only those comments directed toward the process itself are included in the appendices. Several general observations can be made by reviewing the comments and suggestions provided by the project participants. The following paragraphs describe these observations.

4.5.1 Satisfaction with Project Definition/Charrette Process

As shown in the average Customer Satisfaction Index, the Project Definition/Charrette process is greatly favored by most project participants. In particular, the Architect-Engineer firms and the Decision Makers (HRPWC's) think the process is a great improvement over the previous MILCON process. Most of the

A-E's reported that the process enhances their ability to design the project to meet the customer's requirements while still staying within budget. The HRPWC's seem to like their early involvement in the design process and the overall preliminary design results. The USAF Project Managers stated that Project Definition is especially effective in identifying environmental assessments and environmental design that must be conducted before construction begins.

4.5.2 BCE Difficulty with Process

For Base Civil Engineering personnel, who must conduct on-site project programming and host Project Definition and the charrette, the transition to the new process seems to be somewhat difficult. Although most agreed that the process is good (see Section 4.4), if project participants do not fully perform their tasks, the process can break down and leave the BCE with a Facility User and HRPWC who are not satisfied.

4.5.3 Preparation for Project Definition

Several comments referred to the lack of pre-charrette preparation by the project participants, in particular the User and HRPWC. In some cases, the User and HRPWC were uninformed or misunderstood what was required of them during the charrette. It is especially important for these two groups to know extensively their organization's design requirements prior to the start of the charrette. Also, there seems to be some lack of understanding as to what the process involves—week-long meetings with engineers and architects to develop a preliminary design solution.

4.5.4 Team Commitment/Authority Delegated

Several comments dealt with the fact that individuals must be assigned to the Project Management Team early in the process, and these individuals must remain

assigned to the team at least through the design phase, if not the entire project. When individual team positions, such as the User representative or HRPWC, change over the course of the process, breakdowns occur and design changes increase. Also, those individuals assigned as team members must be delegated the authority to make decisions during the process, or the dynamic effect of having on-site analysis and design meetings (charrettes) is lost.

4.5.5 Programmed Amount Drives Process

Several participants commented that there needs to be more flexibility with the project budget (i.e., Programmed Amount) during Project Definition. However, one of the primary reasons the Air Force initiated the new MILCON process was to keep project design and construction costs within the established budget. Some participants suggested that more lenient cost estimates be made when the project budget is established. Other participants suggested that a firm budget not be established until Project Definition is executed.

5.0 Conclusions

5.1 Effect of Project Definition on Design Success

Although a study of only twenty-five projects can not be considered all-conclusive, this study did show that a strong, positive correlation exists between the level of Project Definition effort on Air Force construction projects and the success of the design effort on those projects. The research showed that on projects where the Architect-Engineer or in-house designer conducted thorough on-site data gathering, on-site analysis, and conducted on-site preliminary design with the assistance of the Project Management Team, more successful designs were realized. For the Air Force, design success is defined as little variation between cost estimates and actual costs, little variation from the planned schedule, few if any design changes, low design costs, and a customer that is satisfied with the facility provided to his or her organization. When the new MILCON process is fully and effectively applied, money and time are saved, and the facility users and base commanders are more satisfied with the facility and the construction process.

5.2 Effect of Charrettes on the Project Definition Process

The research showed that conducting charrettes has a positive effect on the Project Definition and Design phases. In every metric measured for Design Success, those projects that had charrettes performed better than those projects that did not have charrettes. However, if the charrette process is to be completely successful the team members must be thoroughly prepared to discuss design requirements and all team members must play an active role in the process. Also, team members should be assigned early in the project, stay on the team throughout the design phase, and be given the authority to make design decisions for the organizations they represent.

5.3 Customer Satisfaction with the Project Definition Process

From the 146 questionnaires returned for inclusion in this study, it is apparent that the project participants were, for the most part, very satisfied with the Project Definition process. The average rating on the question specifically asking the participant's opinion of the process was 7.66 on a scale of 1 to 10, with 10 being the highest. Additionally, the average index on the Customer Satisfaction Sub-Matrix was 812 on a scale from 0 to 1000, with 1000 being the highest. Having the facility user and project decision maker involved in the development of a preliminary design not only improves the process by reducing changes, it also improves the users' satisfaction with the product designed and with the entire process.

6.0 Recommendations

6.1 Actions Based on this Research

Based on this research, the following three actions are recommended for AFCEE:

1. Continue to Use the Project Definition Process. This study has shown strong evidence that the new MILCON process produces successful design efforts. As one questionnaire respondent said, *"The Project Manager's Guide to Project Definition* is a comprehensive, common sense approach to architectural programming and concept design." Having the facility user and decision maker involved in preliminary planning is critical to the successful design of any facility. Additionally, having all interested parties involved in face-to-face charrette meetings builds teamwork and improves overall project performance.

2. Improve Process Awareness and Pre-Charrette Preparation. As shown from the comments and suggestions received from the participating project groups (PM, A-E, BCE, Agent, User, HRPWC), the Air Force needs to focus more effort in preparation for the charrette. Specifically, the Facility User and HRPWC need to know explicitly what their organizations' design requirements are. Also, more effort needs to be placed on educating all project participants on what the process involves, when the charrette meetings will take place, and what is expected of each individual. When the User does not know his or her organization's requirements or when various individuals do not fully participate in the process, the effect of having face-to-face meetings is lost.

3. Continue to Monitor Project Definition. AFCEE needs to monitor Project Definition by using the Design Success Matrix used in this study or some other form of rating as a benchmark of how a project is performing and what needs to be

improved in order to have successful design and construction efforts on that project. As shown from this study, the level of Project Definition effort can predict the level of design success. The Construction Industry Institute (CII) is conducting research into the development of a Project Definition Rating Index for General Building, and CII has Predictive Tools computer software that could aid AFCEE and other Major Commands in monitoring the early phases of their construction projects.

6.2 Actions Based on General Observations

Enroll the Air Force in the Construction Industry Institute. For the past twelve years, CII has conducted extensive research and produced cost saving initiatives for the entire construction process. A few of the areas studied include Pre-Project Planning, Design, Quality Management, Safety, Project Team Building, Constructability, Electronic Data Management, and Partnering. These research initiatives benefit not only construction contractors but owner organizations as well. The U.S. Army Corps of Engineers and the U.S. Naval Facilities Engineering Command have both joined CII with very positive results. CII contains a wealth of construction information and the Air Force and AFCEE need to take advantage of that information.

6.3 Future Research

From this study, the following areas of further research are recommended:

1. Project Definition versus Construction Success. This study showed that Project Definition has a positive correlation with the level of design success. An additional investigation should be conducted to study the effect Project Definition has on the outcome of the entire project. It may be possible to study the same projects used in this research.

2. Development of a Predictive Tool Specifically for the Air Force Construction Process. As mentioned in the previous section, the Air Force should continue to rate its Project Definition efforts as a means of monitoring the early stages of its projects in order to predict the level of overall project success. The tool should be relatively simple to use and produce some sort of numerical rating.

3. Feasibility of the Air Force or AFCEE Joining CII. As discussed previously, the benefits of joining CII are extensive. A study could be conducted to show the benefits versus the costs of membership.

Appendix 1

Air Force Project Manager (DM/CM)

This questionnaire will be used to analyze and improve the Project Definition process on U.S. Air Force military construction projects. It is important that you provide accurate information. If you are uncertain about any particular question or response, please review the Project Manager's Guide to Project Definition or the Project Definition Tutor. On projects where AFCEE is also the DA/CA, please complete the Design Agent survey after completing the DM/CM survey

Project Name: ______________________________

Project Location (Base): ______________________________

Interviewee Name: ____________________ Date: __________

Organization: ______________ Phone: ________ Fax: ______

Please check all appropriate responses for the project listed above.

General Project Information

1. Project Delivery Strategy:
   ☐ Design-Bid-Build ☐ Design-Build ☐ Turnkey
   ☐ Other ______________

2. Design Criteria:
   ☐ Traditional Design ☐ Site Adapt ☐ Definitive Guide (e.g. Dorm Guide)
   ☐ Other ______________

3. DM/CM:
   ☐ AFCEE DM ☐ AFCEE CM

4. Design Agent:
   ☐ Corps of Engineers ☐ NAVFAC ☐ Air Force

5. Which of the following (if any) were used on this project?
   ☐ charrettes ☐ on-site data gathering ☐ on-site analysis ☐ on-site design

Please fill in the blank.

Project Cost Information

1. Please provide the CWE of the Parametric Cost Estimate that was developed during Project Definition. $ ________________________.

2. Please provide the CWE of the A-E/Designer's cost estimate provided to you when the design was 100% complete. $ ________________________.

3. Please provide the awarded contractor's cost for this project (i.e. Low Bidder's CWE).$ ________________________.

4. Please provide the amount for which this project was programmed by the MAJCOM (i.e. Programmed Amount). $ ________________________.

5. How many design changes resulting from approved comments were issued to the A-E/Designer after Project Definition during the design of this project? ____________

6. What was the cost to the Air Force for the design changes ordered during the design phase (from PD to Award) for this project? $ __________________(A-E cost) $ ________________________(in-house cost)

7. What was the total design time required for this project?
   a. from A-E Notice to Proceed to Construction Award____________________
   b. from Project Definition to Construction Award _______________________

8. How much time was added to the design schedule due to changes after Project Definition?__________________________

9. What was the cost to the Air Force for the entire Project Definition phase? $ ______________________(A-E cost) $ _______________________(in-house cost)

10. What was the cost to the Air Force to complete the design phase from PD to Award? $ ____________________(A-E cost) $ __________________(in-house cost)

For each of the following statements, please circle the response (1-10) which best represents your agreement or disagreement with the statement. Please fill in the blanks for the follow-on questions.

Project Management Team

1. The A-E firm/in-house design team chosen to conduct the charrettes during the Project Definition phase of this project was well prepared and effectively led the on-site analysis and design required by the contract.

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

2a. The Cost Estimator used by the A-E/Designer to prepare the parametric cost estimate performed well.

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

2b. The Cost Estimator used by the A-E/Designer to prepare the parametric cost estimate provided <u>on-site cost information</u> during the charrette for alternative design decisions.

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

3. The Design Agent (U.S. Army Corps of Engineers, U.S. NAVFAC, or U.S. Air Force) contributed greatly to the successful completion of the Project Definition process.

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

4. The Facility End User/Future Occupant was actively involved and effectively communicated his/her unit's design requirements to the A-E during the Project Definition phase of this project.

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

5. The Highest Ranking Person With Concern (HRPWC)/Decision Maker for this

project was effectively involved in the decision making process during the Project Definition phase.

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

6. The Base Civil Engineering staff responsible for this project helped solve problems, effectively supported the designer, and contributed adequate information during the Project Definition phase.

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

7. The Major Command (MAJCOM) responsible for this project helped solve problems and provided adequate guidance during the Project Definition phase.

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

8. The Base Support Team (Fire Dept., Comm., Safety, etc.) provided early, timely, and adequate design requirements during the Project Definition phase.

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

9. The Outside Agencies (EPA, Utilities, Historical, etc.) involved with this project provided early, timely, and adequate design requirements during the Project Definition phase.

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

10. As the Air Force Project Manager, I feel I was effective in bringing the Project Management Team to consensus.

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

<u>NOTE</u>: If you did not manage this project during Project Definition, still evaluate your predecessor.

If not effective, what prevented you or your predecessor from being effective?

11. I feel the right people were involved in the Project Definition process.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

If not, who should have been more involved?

12. I was satisfied with the Project Definition process, because I believe the process enhanced the final product.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

Project Definition Products

1. The Project Management Plan developed for this project effectively communicated strategic decisions and the project management team's membership, roles, and responsibilities.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

2. At the Pre-Definition Conference, the project scope, customer requirements, Base Comprehensive Plan (BCP), base standards, and environmental issues were reviewed with the A-E/Designer, and all project team member responsibilities were defined.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

3. The Data Gathering and Requirements Analysis portions of the process produced the needed information to make critical design decisions during Project Definition.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

4. The Site Development Plan produced during Project Definition adequately depicted all site requirements; utility systems' sizes, loads, and connection points; rough site contours and parking; and it contributed to validating the building support cost (outside the 5' line).

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

5. The Schematic Floor Plan developed during Project Definition satisfied the user by adequately depicting all space requirements of the facility.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

If the user was not satisfied, why not?________________________________

____

How many alternative floor plans were developed?____________________

6. Design criteria and building subsystem (such as exterior wall, roof, mechanical, electrical, structural, communications, etc.) narratives (with alternatives) were fully and accurately developed during Project Definition.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

7. The Building Elevations produced during Project Definition complied with base architectural standards and the BCP.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

8. The Parametric Cost Estimate developed during the charrette was accurate.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

9. The Environmental Checklist developed during Project Definition alerted the Project Management Team to the existence of critical environmental issues.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

10. Please provide any comments or suggestions you have on improving the Project Definition process. Your frank and honest input to this study is critical.

____

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____

<u>Thank you</u> for your cooperation in filling out this questionnaire. If you are also the DA/CA, please complete the Design Agent survey listed hereafter.

Appendix 2

Architect-Engineer (or In-House Designer)

Project Name: ____

Project Location (Base): ____________________________________

Interviewee Name: __________________________ Date: ______________

Company: _____________________ Phone: ___________ Fax: _________

For each of the following statements, please circle the response (1-10) which best represents your agreement or disagreement with the statement. Please fill in the blanks for the follow-on questions.

1. The facility user's requirements were clearly defined during Project Definition.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

2. The project goals and requirements were identified and validated before design started.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

3. The Project Definition process was adequately communicated to my firm/designers.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

4. During Project Definition I was able to discuss and present all feasible design alternatives (floor plans, site plans, etc.).

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

5. A consensus was reached among project team members on selected design alternatives and building sub-systems.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

6. The right people (facility user, decision maker, base support, outside agencies, etc.) were involved in the Project Definition process.

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

If not, who should have been involved or more involved? ________________
____

7. The charrette(s) provided a design solution:

a. To a satisfied customer,

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

b. In less time,

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

c. At a lower cost.

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

8. The 'Library Wall', if used, was an effective communication technique in bringing the team to a consensus.

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0 ··· NA

NOTE: The Library Wall is a temporary wall display of information that relates to the project.

9. How much time was added to the design schedule due to Air Force changes after Project Definition?____________________________________

10. I was satisfied with the Project Definition process, because I believe the process enhanced the final product.

strongly agree — agree — slightly agree — neutral — slightly disagree — disagree — strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

11. Please provide any comments or suggestions you have on improving the Air Force's Project Definition process. Your frank and honest input to this study is critical.

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Thank you for your cooperation in filling out this questionnaire. Please enclose the completed questionnaire in the envelope provided and mail it by 19 Jul 95.

Appendix 3

Base Civil Engineering Staff

Project Name: ____

Project Location (Base): ____________________________________

Interviewee Name: ___________________________ Date: ______________

Organization: ____________________ Phone: ____________ Fax: __________

For each of the following statements, please circle the response (1-10) which best represents your agreement or disagreement with the statement. Please fill in the blanks for the follow-on questions.

1. The facility user's requirements were clearly defined during Project Definition.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

2. The project goals and requirements were identified and validated before design started.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

3. The Project Definition process was adequately communicated to my organization.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

4. All feasible design alternatives (floor plans, site plans, etc.) were considered during Project Definition.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

5a. A consensus was reached among project team members on selected design alternatives and building sub-systems.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

5b. The Base Support Team (Fire Dept., Comm., Safety, etc.) provided early, timely, and adequate design requirements during the Project Definition phase of this project.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

6. The right people (facility user, decision maker, base support, outside agencies, etc.) were involved in the Project Definition process.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

If not, who should have been involved or more involved? ________________

____

7. The charrette(s) provided a design solution:

a. To a satisfied customer,

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

b. In less time,

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

c. At a lower cost.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

8. The 'Library Wall', if used, was an effective communication technique in bringing the team to a consensus.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0 ·· NA

<u>NOTE</u>: The Library Wall is a temporary wall display of information that relates to the project.

9. Compared with other facilities of this type, this facility will be easy (physically and economically) to maintain.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

10. This facility will fit in well with the architectural scheme of the base.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

11. I was satisfied with the Project Definition process, because I believe the process enhanced the final product.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

12. Please provide any comments or suggestions you have on improving the Air Force's Project Definition process. Your frank and honest input to this study is critical.

____

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<u>Thank you</u> for your cooperation in filling out this questionnaire. Please enclose the completed questionnaire in the envelope provided and mail it by 19 Jul 95.

Appendix 4

Design Agent
(Corps of Engineers, NAVFAC, or Air Force)

Project Name: ____

Project Location (Base): ______________________________________

Interviewee Name: ________________________ Date: ______________

Organization: __________________ Phone: ____________ Fax: _________

For each of the following statements, please circle the response (1-10) which best represents your agreement or disagreement with the statement. Please fill in the blanks for the follow-on questions.

1. The facility user's requirements were clearly defined during Project Definition.

strongly agree | agree | slightly agree | neutral | slightly disagree | disagree | strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

2. The project goals and requirements were identified and validated before design started.

strongly agree | agree | slightly agree | neutral | slightly disagree | disagree | strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

3. The Project Definition process was adequately communicated to my organization.

strongly agree | agree | slightly agree | neutral | slightly disagree | disagree | strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

4. All feasible design alternatives (floor plans, site plans, etc.) were considered during Project Definition.

strongly agree | agree | slightly agree | neutral | slightly disagree | disagree | strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

5. A consensus was reached among project team members on selected design alternatives and building sub-systems.

strongly agree | agree | slightly agree | neutral | slightly disagree | disagree | strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

6. The right people (facility user, decision maker, base support, outside agencies, etc.) were involved in the Project Definition process.

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

If not, who should have been involved or more involved? ____________________

____

7. The charrette(s) provided a design solution:

a. To a satisfied customer,

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

b. In less time,

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

c. At a lower cost.

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

8. The 'Library Wall' if used, was an effective communication technique in bringing the team to a consensus.

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0 ··· NA

NOTE: The Library Wall is a temporary wall display of information that relates to the project.

9. I was satisfied with the Project Definition process, because I believe the process enhanced the final product.

strongly agree   agree   slightly agree   neutral   slightly disagree   disagree   strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

10. Please provide any comments or suggestions you have on improving the Air Force's Project Definition process. Your frank and honest input to this study is critical.

____

____

____

____

____

Thank you for your cooperation in filling out this questionnaire. Please enclose the completed questionnaire in the envelope provided and mail it by 19 Jul 95.

Appendix 5

Facility User

Project Name: ____

Project Location (Base): ____

Interviewee Name: __________________________ Date: ______________

Organization: ____________________ Phone: ____________ Fax: __________

For each of the following statements, please circle the response (1-10) which <u>*best*</u> *represents your agreement or disagreement with the statement. Please fill in the blanks for the follow-on questions.*

1. My organization's requirements were clearly defined during Project Definition.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

2. The project goals and requirements were identified and validated before design started.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

3. The Project Definition process was adequately communicated to my organization.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

4. All feasible design alternatives (floor plans, site plans, etc.) were considered during Project Definition.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

5. A consensus was reached among project team members on selected design alternatives and building sub-systems.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

6. The right people (facility user, decision maker, base support, outside agencies, etc.) were involved in the Project Definition process.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

If not, who should have been involved or more involved? ________________

____

7. The charrette(s) provided a design solution:

a. To a satisfied customer,

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

b. In less time,

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

c. At a lower cost.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

8. The 'Library Wall', if used, was an effective communication technique in bringing the team to a consensus.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0 ·· NA

NOTE: The Library Wall is a temporary wall display of information that relates to the project.

9. This facility will meet the mission needs of my organization.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

10. This facility will enhance the job effectiveness of the personnel in my organization.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

11. I was satisfied with the Project Definition process, because I believe the process enhanced the final product.

strongly agree	agree	slightly agree	neutral	slightly disagree	disagree	strongly disagree

10 ···· 9 ······ 8 ······ 7 ······ 6 ······ 5 ······ 4 ······ 3 ······ 2 ······ 1 ······ 0

12. Please provide any comments or suggestions you have on improving the Air Force's Project Definition process. Your frank and honest input to this study is critical.

____

____

____

<u>Thank you</u> for your cooperation in filling out this questionnaire. Please enclose the completed questionnaire in the envelope provided and mail it by 19 Jul 95.

Appendix 6

Highest Ranking Person With Concern/Decision Maker

Project Name: ____

Project Location (Base): ______________________________________

Interviewee Name: ___________________________ Date: _______________

Organization: _____________________ Phone: ____________ Fax: _________

For each of the following statements, please circle the response (1-10) which <u>*best*</u> *represents your agreement or disagreement with the statement.*

1. The facility user's requirements were clearly defined during Project Definition.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

2. This facility will enhance the mission effectiveness of the base.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

3. I was satisfied with my involvement in the final design decisions made during Project Definition.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

4. I was satisfied with the Project Definition process, because I believe the process enhanced the final product.

strongly agree		agree		slightly agree	neutral	slightly disagree		disagree		strongly disagree
10	9	8	7	6	5	4	3	2	1	0

5. Please provide any comments or suggestions you have on improving the Air Force's Project Definition process. Your frank and honest input to this study is critical.

____

____

____

<u>Thank you</u> for your cooperation in filling out this questionnaire. Please enclose the completed questionnaire in the envelope provided and mail it by 19 Jul 95.

Appendix 7

Performance Criteria						
	Satisfied with Process	HRPWC Involvement	Meets Mission Needs	Functionality	Maintability	Aesthetics
Data Source	Note 1	HRPWC	Note 2	User	BCE	BCE
10						
9		X				
8			X		X	
7	X					X
6				X		
5						
4						
3						
2						
1						
0						
SCORE	7	9	8	6	8	7
WEIGHT	10	10	25	25	15	15
VALUE	70	90	200	150	120	105

SCORES

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Note 1: Includes all survey interviewees.
Note 2: Includes Facility End User and HRPWC.

Example Customer Satisfaction Sub-Matrix

Performance Criteria								
	100% Estimate vs. PCE	Bid Cost vs. PCE	100% Estimate vs. Programmed Amount	Cost of Changes During Design	Cost of Project Definition Effort	Cost of Design	Impact of Changes on Design Schedule	Customer Satisfaction
Data Source	PM	PM	PM	PM	PM	PM	PM	Note 1
10	0	0	0	0	0.2	4.5	0	1000
9	1	1	1	1	0.7	5.5	1	900
8	2	2	2	2	1.2	6.5	2	800
7	3	3	3	3	1.7	7.5	3	700
6	4	4	4	4	2.2	8.5	4	600
5	5	5	5	5	2.7	9.5	5	500
4	6	6	6	7	3.2	10.5	7	400
3	7	7	7	10	3.7	11.5	10	300
2	8	8	8	15	4.2	12.5	14	200
1	9	9	9	20	4.7	13.5	17	100
0	10+	10+	10+	25+	5.2+	14.5+	20+	0
SCORE	3	7	4	8	6	8	10	7.35
WEIGHT	15	20	10	15	5	5	5	25
VALUE	45	140	40	120	30	40	50	184

SCORES

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Note 1: Includes Facility User, BCE, and HRPWC (see Customer Sat. sub-matrix)

Example Design Success Matrix

Performance Criteria	Project Mgt Plan	Pre-Definition Conf.	Data Gathering/ Req'ts Analysis	Site Plan	Floor Plan	Building Sub-Systems	Elevations	Cost Estimate	Environmental Checklist
Data Source	PM	PM	PM	PM	PM	PM	PM	PM	PM
SCORES 10									
9				X	X		X		
8									
7									
6		X							
5			X						
4	X								
3									X
2						X			
1								X	
0									
SCORE	4	6	5	9	9	2	9	1	3
WEIGHT	5	10	15	15	20	10	5	15	5
VALUE	20	60	75	135	180	20	45	15	15

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Example Project Definition Products Sub-Matrix

Performance Criteria	User Req'ts Defined	Project Goals Defined	PD Process Explained	Design Alternatives Considered	Consensus Reached	Right People Involved	Charrette	Library Wall
Data Source	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1	Note 1
SCORES 10								
9								
8								
7								
6							X	
5						X		
4								
3	X				X			
2		X		X				
1			X					
0								X
SCORE	3	2	1	2	3	5	6	0
WEIGHT	30	5	5	5	25	10	15	5
VALUE	90	10	5	10	75	50	90	0

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Note 1: Includes A-E, BCE, Facility User, HRPWC and Design Agent.

Example Project Definition Process Sub-Matrix

Performance Criteria	A-E	Cost Estimator	Design Agent	Facility User	HRPWC/Decision Maker	BCE	MAJCOM	Base Support	Outside Agencies	Project Manager
Data Source	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM
SCORES 10										
9					X	X				X
8							X			
7	X	X						X		
6										
5			X						X	
4				X						
3										
2										
1										
0										
SCORE	7	7	5	4	9	9	8	7	5	9
WEIGHT	25	5	5	10	10	8	5	7	5	20
VALUE	175	35	25	40	90	72	40	49	25	180

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Example Project Management Team Sub-Matrix

Performance Criteria	Project Mgt Team	PD Process	PD Products
Data Source	PM	Note 1	PM
SCORES 10	1000	1000	1000
9	900	900	900
8	800	800	800
7	700	700	700
6	600	600	600
5	500	500	500
4	400	400	400
3	300	300	300
2	200	200	200
1	100	100	100
0	0	0	0
SCORE	7.31	3.30	5.65
WEIGHT	33.3	33.3	33.3
VALUE	243	110	188

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Note 1: Includes A-E, Facility User, BCE, HRPWC, and Design Agent.

Example Project Definition Matrix

Appendix 8

Project Manager Comments

The following comments pertaining to Project Definition were taken from the Air Force Project Manager Surveys:

The decision maker for the entire project/organization needs to be identified at the very beginning and his/her decisions followed without second guessing or changing by others later.

A-E's should consider contaminated site soil assessment before designing project.

The environmental assessment should be completed or be on its way to being completed.

Many environmental studies had to be taken because Project Definition identified holes in the requirements.

Improve cost information at Project Definition.

Project Definition process worked well and minimized scope and programming changes caused by force structure impacts.

I don't recognize any need to improve the process; the challenge is to adapt the details of the process to the unique mix of personalities, skills, and experience of the key team members and the specific project requirements.

...the cooling off period for reflective review was beneficial after the first Project Definition presentation.

Appendix 9

Architect-Engineer Comments

The following comments pertaining to Project Definition were taken from the Architect-Engineer Surveys:

The Project Definition went well. A key element to its success was the involvement of the environmental department from the beginning. Had their input not been solicited, design changes would have been the result.

The Project Definition/on-site design charrette was instrumental in providing a smooth design process without major changes, backtracking, or rework. Its results were a superior product, responsive to the users needs, accomplished within schedule and budget. I highly recommend that this process continue on future MILCON projects. It works; "it ain't broke, don't fix it."

Project Definition must occur prior to or along with establishing the project construction budget. If the budget is established prior to Project Definition, the project is arbitrarily constrained.

A facility "design criteria", developed by the facility user is also a good method. However, some users may not have the capabilities to develop one.

Corps of Engineers and User Representative personnel changes causes breakdowns and a loss of knowledge of decisions made earlier in the project.

Our schedule was compressed...we could not have produced this amount of work in such a short time unless all user input was collected at the beginning of the project. The **Project Manager's Guide to Project Definition** *is a comprehensive, common sense approach to architectural programming and concept design. We support the continued use of this process.*

A lessons learned conference at the site would be helpful and beneficial to all participants at the completion of construction or at 90% completion of construction.

I like the Project Definition process, because it very clearly spells out everything that is required for the final product. The process saves the A-E design team a fair amount of time.

Having the project defined more clearly prior to beginning Project Definition would greatly improve the A-E's response time during Project Definition.

A qualified, knowledgeable person should evaluate the "electronic input" (base sheets) prior to giving it to the design team.

Recommend a "configuration change board" be established, for each project, to review and approve changes to scope of design, PA, CCL, and contracting strategies after final project definition approval. The board should consist of team members familiar with the project but not participating in the day to day design and project management effort.

Recommend, as a part of Project Definition, the contracting strategy and bid schedule be developed and approved.

Having everyone involved with the building together to have an open discussion about the building program, organization, aesthetics, etc. was extremely productive. It made a lot more sense than a designer, with no working knowledge of how the facility will be used, sitting alone, trying to make decisions about which spaces can be trimmed or moved in order to get the building within the programmed square footage...Overall it seemed to be a much better way to handle the project definition and early design process as long as everyone who is included is relevant and no one bogs down the meeting with their own personal petty agenda. There was very little of this in our meetings but the potential for this is very high. Overall—excellent—please continue this format.

The Project Definition process proved very effective in developing this project, actually leading to an Air Force Design Award.

...Project Definition was, in fact, no more than an exercise in schematic design. Few, if any, of the other design-related agencies (MAJCOM, BCE, Corps of Engineers) had any insight into the process or purpose of "project definition".

Appendix 10

Base Civil Engineering Staff Comments

The following comments pertaining to Project Definition were taken from the Base Civil Engineering Staff Surveys:

Charrette process is good. Problems could arise if the Programmed Amount is too low to meet valid user requirements. It is, however, time well spent.

Make sure the base project manager "buys off" on the Project Definition.

The charrette process is a great, efficient process; it was just a little difficult. The user and customer are very pleased.

Charrette process is time well spent. It tends to define the 'ideal" facility early-on. Could cause some customer disappointment when the facility funding is factored in and some "nice to haves" have to be cut from the facility.

On design-build projects, the project goals seem to "blur" once the design-build/fast-track effort starts.

The "team in-action" was evident even though charrettes were not used.

There was simply no substitute to the combined Command, Wing, A-E and local user team spending two weeks on station. This produced not only a Project Definition but a Preliminary submittal as well.

The facility users should identify their organization's requirements prior to the start of Project Definition.

Project Definition replaced a very much superior process using a lengthy checklist (this should have never been abandoned) that provided the information needed to start the designer on his way. Designers are now tasked to provide the Project Definition which is expensive and does not necessarily improve the final product. A good A-E should be able to proceed (as they did for years) with the old checklist that was done carefully by the base C.E. We seem to think that a change is always for the better.

Appendix 11

Design Agent Comments

The following comments pertaining to Project Definition were taken from Design Agent Surveys:

The Project Definition process is a good process, and it is the best to come along in a long time. However...until the user is willing to get off his tail and get involved in the project from the beginning, the project is doomed to a costly design.

The key to the Project Definition success for this project was the result of an innovative design approach by the A-E and the determined coordination by the AFCEE PM. The PM was willing to make on-the-spot decisions at the charrette. This saved weeks (probably months) of time and allowed the A-E to make some very innovative design choices, saving the Air Force significant construction dollars.

The decision makers need to delegate the design responsibility to their PM's and honor their commitments. Project requirements changed frequently due to decision maker changes.

The use of the charrette probably had no impact on this project since a key command player came in late and changed requirements.

There is a misconception that charrettes produce a product at a lower cost. The A-E community treats the charrette as an additional indirect project design cost. You pay to design the facility plus you pay an additional amount for the charrette. If the Air Force (customer) could perform the charrette internally prior to getting a designer involved, you could probably save some design money.

Recommend that all DIs, RAMPs, DD Forms 1391, other criteria and design funding be provided to the design agent in accordance with the Military Construction Program Goals, i.e. March of FY minus 2.

It is important that input from BCE/Planning, Communications, Security, & Fire Department also be included during Project Definition, particularly to be available during the charrette process.

...The Project Definition process may be improved on other projects if the customer has better thought out the entire process and project requirements. Many times the end-user is not notified (or hasn't been communicated) of the importance of knowing

exactly what they're expecting—definite goal—at the project inception/criteria review conference.

Adequately program project funding!...There are no excess funds to increase the PA...Design has proceeded on several projects with CWE above PA to meet users needs.

Someone needs to explain the process to the unit commanders. They don't have experience with the MCP process and don't understand project limitations or schedule requirements.

Project Definition is fine when the particular people are present. Many times a few critical people are absent due to TDY, training, or poor meeting establishment date(s).

Appendix 12

Facility User Comments

The following comments pertaining to Project Definition were taken from the Facility User Surveys:

Too little realization that productivity is a driver—most of upper level concern is "make it fit, get it done"—this needs to change. Also, initial cost estimates too low.

All phases of the project need to be reviewed to reduce "total time" of the project. I watched two complete malls, two shopping centers, and a race track constructed and am still waiting for two buildings to be finished. The process is too long. Concentrate on the Corps of Engineers.

The charrette serves a valuable service of early team identification, customer buy-in, and functional accountability—very worthwhile. Cost (programmed amount) still drives overall scope and execution.

It seemed as the process progressed, we had less and less say in the decisions made.

Appendix 13

HRPWC Comments

The following comments pertaining to Project Definition were taken from the HRPWC Surveys:

Excellent results.

Outstanding process from user standpoint.

Tremendous flexibility; truly enabled our unit to tailor our facility to unique mission requirements. PM did a fantastic job.

Advance written notification of PD meeting with bullet comments of what to have prepared for the PD would help "users" come adequately prepared.

The charrette process was exceedingly productive in providing a quality building design. By bringing all interested parties together in one room, the required facility elements were efficiently and effectively packaged in a timely manner.

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VITA

Robert Matthew Crafton was born in Rogers, Arkansas on October 30, 1967, the son of Bob H. Crafton and Bonnie Crafton. After graduating from Rogers High School with honors in 1986, he received an appointment to attend the United States Air Force Academy in Colorado Springs, Colorado. Upon graduation from the Air Force Academy with a Bachelor of Science degree in Civil Engineering, he was commissioned a second lieutenant in the United States Air Force. He served one and a half years as an environmental engineer at Eaker Air Force Base, Blytheville, Arkansas, participating in Operation DESERT STORM in 1992. After the assignment at Eaker, he was assigned as a construction project engineer at the 823rd RED HORSE Squadron, Hurlburt Field, Florida. For his actions in Operation RESTORE HOPE in Somalia and other construction efforts, he was named the United States Air Force Outstanding Civil Engineer Military Manager of the Year for 1993. In September 1994, the Air Force sent him back to school, entering The Graduate School at The University of Texas.

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